Small, Efficient Metal-Substrate Catalytic Converter for Trace Contaminant Control

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Spacecraft air-cleaning systems need to minimize weight, volume, power consumption, and requirements for replacement components. NASA Small Business Innovation Research phase II contractor, Precision Combustion, Inc., has developed a very lightweight, compact, high-conversion efficiency "Microlith™" catalyst system (U.S. Patent 5,051,241) for the trace contaminant control system. Earthbound versions of the Microlith™ system being developed for the *International Space Station* are currently in automobile emissions control testing with the top three U.S. domestic auto manufacturers and with a manufacturer of advanced industrial process fume control equipment. Hamilton Standard is exploring putting the technology on aircraft for cabin air cleaning.

The system replaces conventional "monolithic" catalyst substrates with a series of very short, lightweight, highly effective metal substrates, and achieves both rapid lightoff and a ten-fold reduction in size and weight compared to conventional monolithic converters. In the space station application, weight savings are even greater, as the current system relies heavily upon disposable filters. Precision estimates the weight savings represent a dollar savings of up to $4 million per year in station operating costs.

The key feature of Microlith™ technology is its improved geometry/reaction rate. The improved catalytic metal monolith design significantly enhances surface-gas contact through the use of Microlith™ structures with high open areas, small channel diameters, and short channel lengths. Short channel length prevents the significant boundary-layer buildup typical of conventional honeycomb converters. The greatly enhanced mass transfer efficiency becomes especially important for low concentrations of target species. Direct electric heating of the catalytic segment provides positive control over the catalyst temperature and also allows periodic regeneration of the catalyst.

The proof-of-concept phase I prototype test achieved greater than 99-percent destruction of trace organic components per pass through the system, using a small amount of electrical heating at low inlet air temperatures. The phase I Microlith™ test reactor operated at a space velocity of around 40,000 per hour, with greater than 99-percent destruction efficiency of xylene, methanol, 2-propanol, and acetone, as well as methane and ammonia. These conversions demonstrate the ability of the Microlith™ converter to serve as an effective contaminant control system through direct electrical heating of the catalyst. Actual system power requirements for these conversions are being assessed in the continuing phase II work. Efficient packaging of the Microlith™ reactor and determination of optimized operating conditions in a full-scale working prototype are now in progress.

The same technology that offers such fast lightoff and efficiency in the space station is being applied to terrestrial air-pollution problems. Automotive exhaust is the source of nearly half of all U.S. manmade air pollution. With new California and national standards seeking to cut automotive emissions by 75 percent, Precision reports considerable interest from automotive manufacturers and suppliers of exhaust systems, and now has joint development or test programs underway with a number of these companies. Testing to date by automotive manufacturers of prototype designs without any electrical heating have demonstrated that this low-cost, fast-lightoff approach (estimated at less than $50 per vehicle) allows emissions substantially lower than even California's tightest ultra-low emission vehicle standards. For industrial emissions, the small size and rapid lightoff of the technology allow design of point-of-source catalytic oxidation units, offering better individual process control and reduced costs for plant infrastructure. Precision is now in a joint development program with a catalytic fume-burner manufacturer to enter this market.

In a third market, the unit's very low weight and volume offer potential for use in aircraft, for example, in cleaning up aircraft cabin air. Precision and Hamilton Standard are exploring the potential for this application. Precision reports that six U.S. patents have been issued on the technology, and a number more are pending.

Sponsor: Small Business Innovation Research

Industry Involvement: Precision Combustion, Inc.